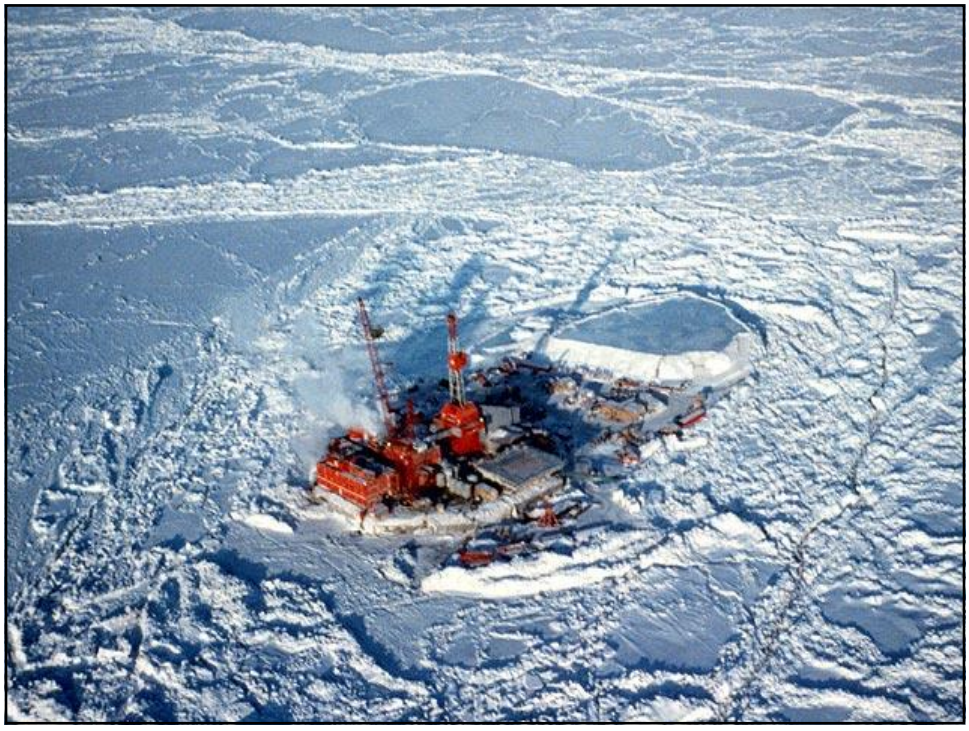
Aker Arctic

New Arctic Vessel and Icebreaking Technologies

Mikko Niini, President
Aker Arctic Technology Inc
International Oil & Ice Workshop
Anchorage 10.10.2007

Preferred for Innovation



Sometimes things are tough

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The challenge: harsh environments

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Winter is cold and dark

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Baltic Sea- a freezing sea

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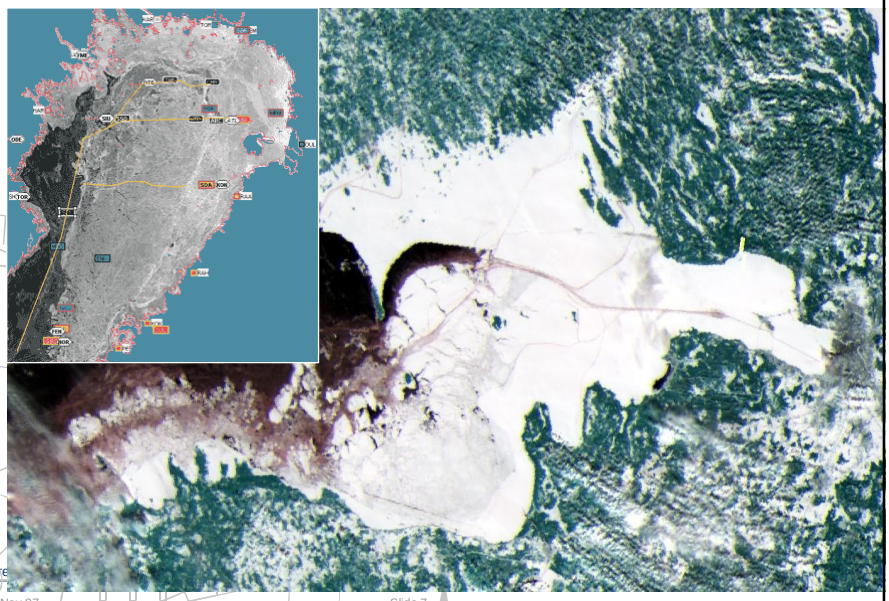

Ice expertise background in the 50 years of Finnish development of icebreakers

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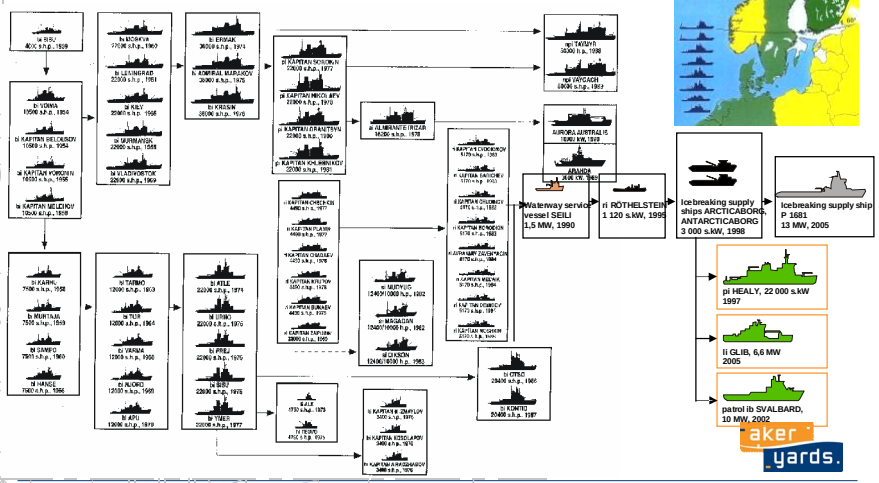

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Idea for ice model tests raised by Exxon along the T/T ”Manhattan” experimental voyages to North Slope

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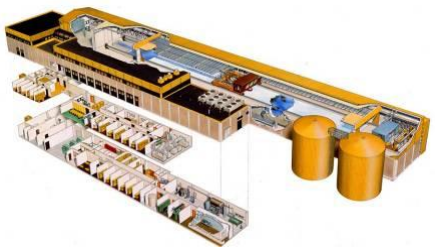
35 years´ ice modelling experience



1954 — Icebreaker ”Voima” delivered

1969 — Project ”Manhattan”, Wärstilä Icebreaking Model Basin (WIMB) established

1982 — Wärtsilä Arctic Research Center (WARC)

1989 — Masa-Yards Arctic Research Center (M...

1991 — Kvaerner Masa-Yards Arctic Technology Center (MARC)

2005 — **Aker Arctic AARC**

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We built the first polar icebreakers and opened the Northern Sea Route for year-round traffic in 1982

19 Arctic dry cargo ships

25 polar tankers

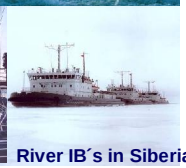
9 Polar icebreakers

2 Nuclear icebreakers

14 River icebreakers

USCG "Healy"

NIB "Taymyr & Vaygach"



River IB´s in Siberia

4-Nov-07 Slide 11

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Our Arctic experience includes design and construction of nuclear icebreakers

4-Nov-07 Slide 12

Multipurpose Icebreakers ”Fennica”, ”Nordica” and ”Botnica” from Aker Yards

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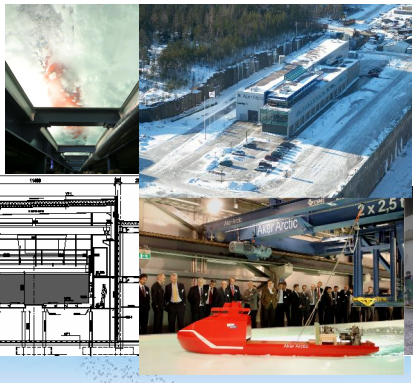
New model testing facility opened in 2006

Aker Arctic

- A new third generation test facility erected in 2005,
- investment 10,3 Mill. €
- Beam increased to allow larger structures to be tested
- Glass bottom to improve observation
- Latest technology for freezing process
- Latest technology for data recording
- Best in the world



Aker Arctic Technology Inc – the global full service ice technology partner

Aker Arctic

- While restructuring Aker Yards operations, ice-related activity was separated from yards to an independent business unit, as a ”center of excellence”, to work globally
- Aker Arctic established and registered in 2005
- Equity 8 Mill. EUR
- AARC shareholders:

Aker Yards	62,5 %
ABB	12,5 %
Aker Kvaerner	12,5 %
Wärtsilä	12,5 %

- Board:
  - Oddvar Slettevold, chairman
  - Magne Håberg, Mikko Niini (AY)
  - Risto Neuvo (AKET), Lasse Mäkelin (ABB Marine), Jari Salo (Wärtsilä Propulsion)
- Turnover from 1,5 to 4,3 Mill. EUR (2006), further growth expected

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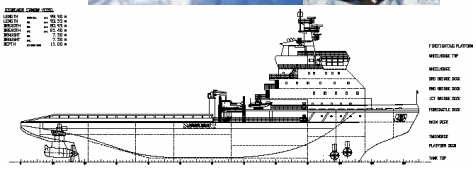
Aker Arctic – today´s center of excellence specialises in tailored solutions for winter and Arctic operations

Aker Arctic

Field research
- Ice conditions
- Ice properties
- Route selection
- Design basis development

Concept development
- Basic design
- Feasibility studies
- Performance predictions
- Simulations

Testing in model and full scale
- Ships and structures
- Offloading operations
- Floaters
- Rescue and evacuation



Preferred for Innovation

Services include assistance to shipowners and shipyards building special vessels or offshore structures

Aker Arctic

Project sales and project execution
- Tender packages, Basic designs
- Aker ARC standard designs
- Licence agreements
- Project executions
- Helsinki yard project design department merged with AARC
- Total staff 30 of which 25 naval architects

Ice navigation training

Design assistance to Avondale

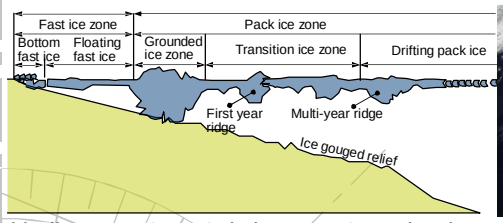
Basic design package to Admiralty Shipyards

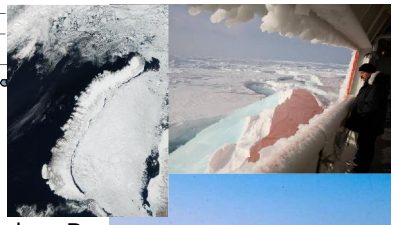
Licence arrangements with other yards like Sumitomo and Samsung

Preferred for

Aker Arctic

Field work has been continued





Sakhalin, Kara Sea, Spitzbergen, Greenland, Hudson Bay

Aker Arctic

Past experience and sufficient ice condition data available for reliable Design Basis

- Sakhalin, 1990/1991/1992/1997/1998/2007
- Barents Sea, 1991/1992/1993/2001/2005
- Pechora Sea, 1992/1993/1994/1998/1999
- Kara Sea, 1993/1995/2006/2007
- Ob Bay, 1995/1996/1998/2000
- Baltic,1994/1995/1996/1997/1998/2003
- Canada Arctic archipelago 2007
- ARCDEV 98, the EU-funded trial trip by M/T “Uikku” to Tambey in April 1998
- M/T “Uikku” Northern Sea Route passage as first foreign merchant vessel 1998

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Full-scale experience, ships and ice conditions

§ BALTIC SEA, Scandinavia	100
§ LAKE SAIMAA, Finland	10
§ LAKE VÄNERN, Sweden	1
§ ARCTIC, Canada	12
§ ALASKA, USA	2
§ GREAT LAKES, USA	3
§ ANTARCTIC	5
§ ARCTIC, Russia	37
§ ARCTIC, Greenland, Spitzbergen	2
§ RIVERS, Russia	13
§ SAKHALIN, Russia	7
§ CASPIAN SEA, Kazakhstan	1

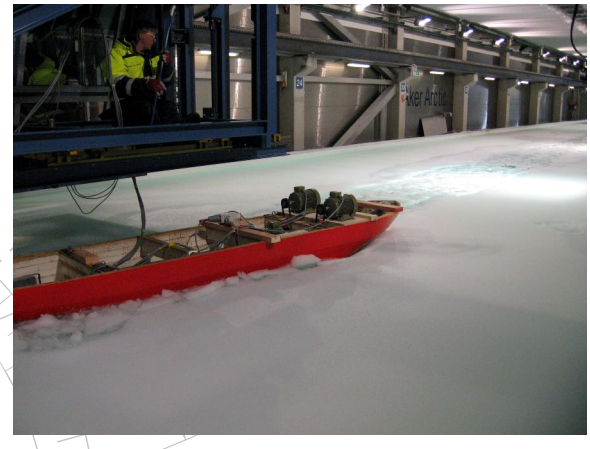
Picture: Aker Arctic DAS™ vessel "Pacific Endeavour" ice testing at Greenland

New challenges met recently

Aker Arctic

AKER ARCTIC PARTICIPATES IN RUSSIA´S PROGRAM FOR NEW NUCLEAR ICEBREAKERS - Record ice conditions created in the new AARC Technology Center

The new generation icebreaker is set to break 2.85 m thick level ice with the power of 60MW. The performance of the tests was very challenging. The scale of the Russian built models resulted to extreme ice thickness in the basin. However, it was noted that the thickness model ice thickness 84mm was reached with no difficulty even in summer outside temperatures. It was also noted that ice thickness well over 100 mm is reachable.
AARC is currently operating its third ice. Later this fall Aker Arctic will take on again new testing challenges as model tests in multiyear ice conditions will be simulated.



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Offshore is an important part of Aker Arctic´s operations

Ice rubble formation on gravity based structures (D-6, Prirazlomnoye, SSDC) and a SPAR.

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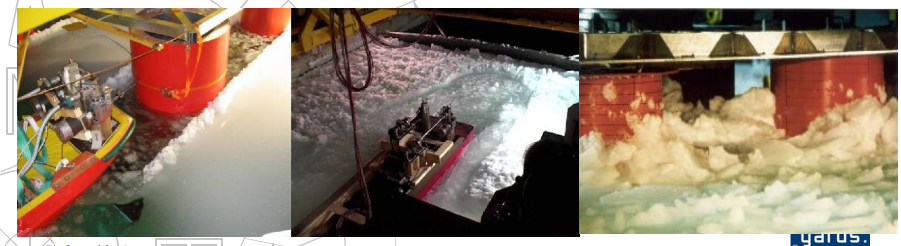
Future needs for ice model tests in offshore activities

- The mission based approach in concept devevelopment call for model testing to set the performance requirements
- New types of activities in offshore operations lead to unkown phenomena, which need to be studied with model tests



The opportunity

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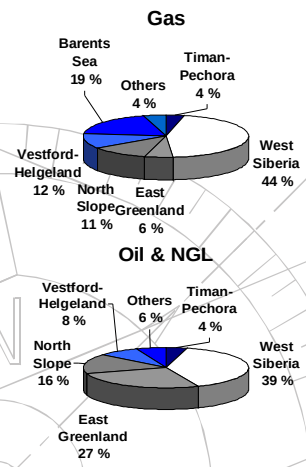
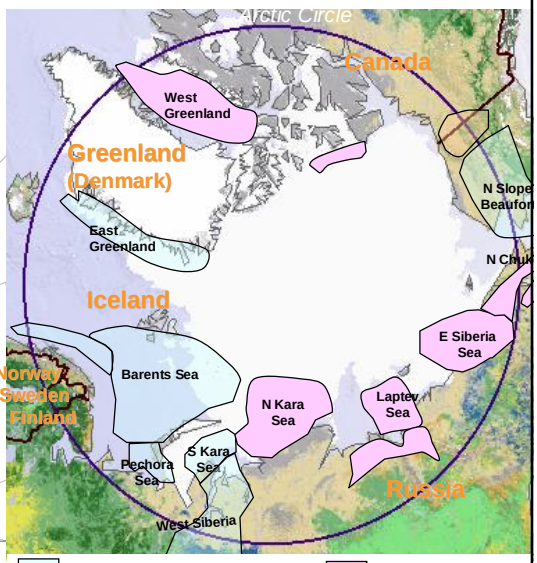
25% of world's undiscovered resource in the Arctic

*USGS study





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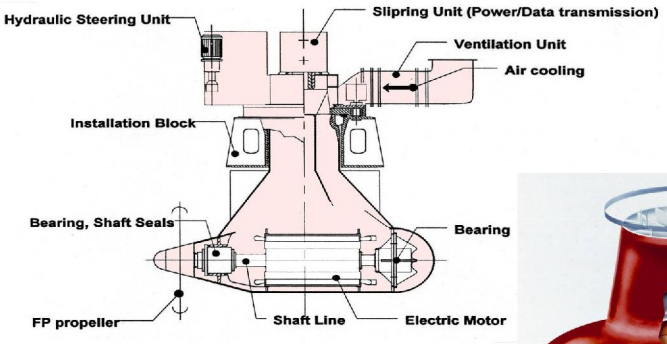
While the market was "dead", important developments took place

- the recent developments for cost efficient Arctic navigation by Aker Arctic

Electric propeller turning 360 degrees and to give full thrust to any direction

Aker Arctic



This turned out to become later Azipod®

Preferred for Innovation

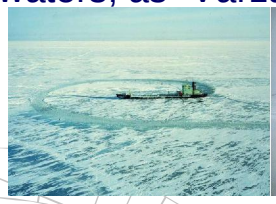
The new propulsion system development and the "Uikku" conversion in 1993

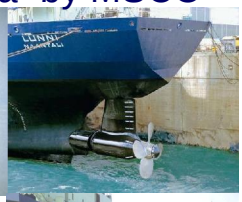
Aker Arctic

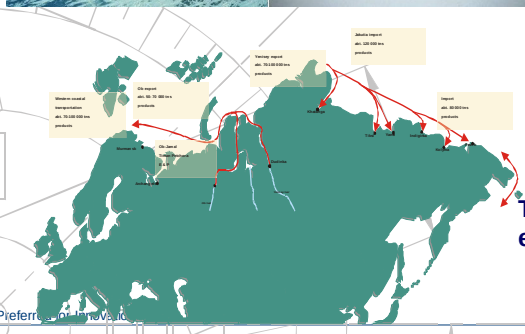
"Seili" prototype 1,5 MW 1989

After 10 years of Arctic pioneering work “Uikku” and “Lunni” are today back in the Arctic waters, as “Varzuga” and “Indiga” by MSCO

Aker Arctic





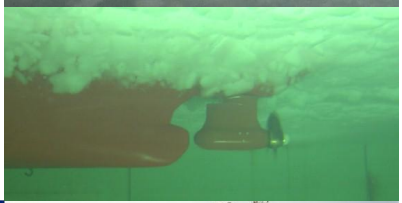


Today 15 years of Arctic experience for pod drives

Aker Arctic DAS™: Innovation by experience

Aker Arctic

- **Excellent performance**
- **Successful running backwards when moving ahead was impossible**
- **Learned a new way of operation**
- **Ridge destruction with the propeller**
- **Best performance in most difficult conditions**
- **Ice resistance down to 50 %**
- **Power requirements down to 60 %**

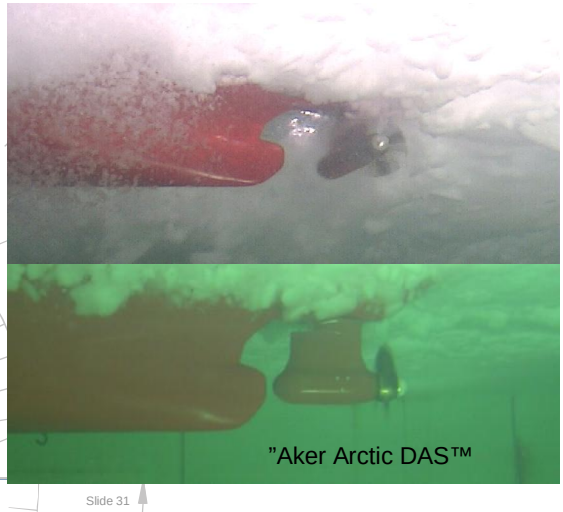



Aker Arctic

Learning by experience: Propeller acts as a big pump to flush the hull

The idea of ”double-acting” vessels is based on azimuthing thrusters flushing the hull by the propeller stream.

In level ice, frozen channels, rubble fields and ridges the propeller flushses the lower ice pieces and ”eats up” the ice rubble.



Aker Arctic

First double-acting IBSSV´s in the North-Caspian, 9 years in service

The Wagenborg “Aker Arctic DAS™” double-acting" icebreaking supply vessels working for AGIP KCO (Kashagan East)

Main dimensions: 65 x 16,4 x 2,9 m

Power 2 x 1,6 MW

icebreaking capacity max. 1,0 m level ice

Penetration through grounded ridges

Aker Arctic

Excellent performance in any conditions

Aker Arctic DAS™ in Great Lakes by USCG

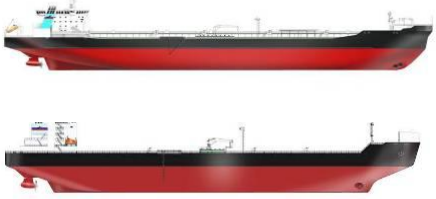
Aker Arctic

Aker leads the way for the maritime industry today

Norilsk Nickel 5 vessels 2006-2009

Sakhalin 1 & 2 projects, all new icebreakers delivered by Aker Yards

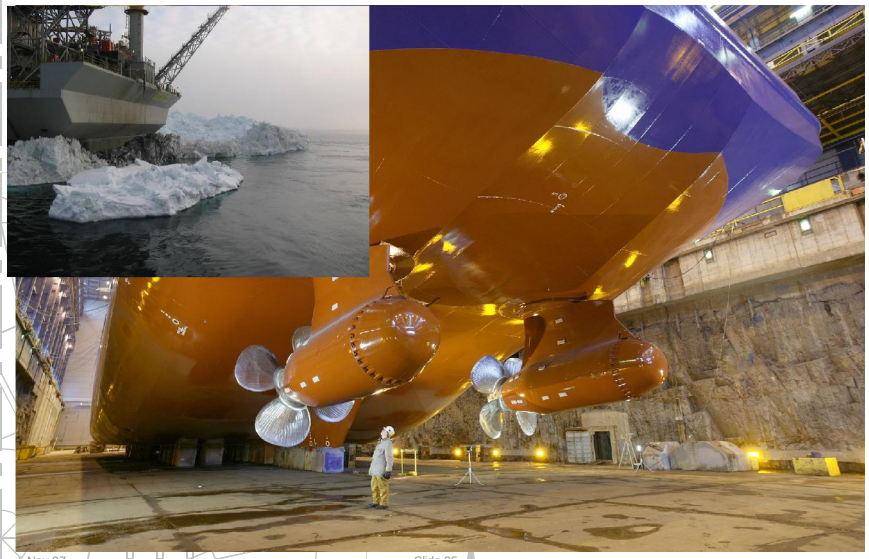
World´s first Arctic oil export systems: Aker Yards´ DAS concept selected 2007/9



2 x 70 ktdw shuttles Admiralty/Gazprom
3 x 70 ktdw shuttles Samsung/LUKoil,COP
2 x 105 ktdw shuttles Sumitomo/Neste Oil

Aker Arctic

”Double-acting” concept thoroughly selected by Exxon



Double-acting performance

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All Sakhalin newbuildings from Aker, all model tested by us

Aker Arctic

AY recently built Ice Classed OSV's

- Fesco Sakhalin
- Polar Pevek
- Pacific Endeavour
- Pacific Endurance
- Pacific Enterprise

Polar Pevek for De Kastri terminal

Aker Arctic

POLAR PEVEK

- TANKER ASSISTANCE IN THE DE-KASTRI TERMINAL
- DNV ICEBREAKER ICE-10
- LOA = 74.3 m
- B = 17.0 m
- T = 6.1 m
- DWT = 940 T
- GT = 3 396
- MCR = 11 000 kW
- 2 * ABB Azipod

Recent Ice Class OSV's

Aker Arctic

PACIFIC ENDEAVOUR

- FIRST OF THREE IB PSV´s FOR SAKHALIN 2 (SHELL)
- DNV ICEBREAKER ICE-10
- LOA = 91.5 m
- B = 19.0 m
- T = 8.2 m
- DWT = 4 482
- GT = 4 992
- MCR = 17 280 kW
- 2 * 7 000 kW RRM Aquamaster ARC 1.0

Picture from Swire Pacific Web-site

4-Nov-07 Slide 39

Another Aker Yards built icebreaker, tested in model scale and full scale by Aker Arctic in Greenland and Spitzbergen

Aker Arctic

- Three UT 758 IBPSV´s for Sakhalin 2 project
- Delivered in April-October 2006
- Built by Aker Yards AS, Søviknes and Langsten, Norway
- Two 7,5 MW mechanical azimuthing thrusters
- Aker Arctic DAS™

Prefe

4-Nov-07 Slide 40

Aker Arctic

Our ultimate goal: cost efficient volume transports in Arctic

Aker Arctic

”Tempera” commissioned in winter 2003

Aker Arctic

M/T Tempera now five years in service

Ice performance verified in practical work in the Primorsk export shuttle service.

Full scale trials in 2003:

- **level ice 80 cm at 5,0 kn**
- **broken channels 7 knots**
- **ice ridges (4 metres) at 3 knots**
- **maximum ridge penetration 13 metres (maximum) found in the region)**

Preferred for Innovation

Aker Arctic

”Norilskiy Nickel” in Kara Sea, March 2006

Delivered after succesful ice trials on April 12th, 2006. Vessel currently in regular trade from Murmansk to Dudinka in the Kara Sea, proving her capability in year-round independent operation. Ice class 1D.

Aker Arctic

Proven ice performance lead to a contract for four more vessels under a licence from Aker Arctic

- Ice condition: level ice 1.5 m, strength 700-800kPa
- Power: 13 MW
- Speed Astern: 1.75 m/s (3,3 kn), Ahead 1.25 m/s (2,3 kn) (model tests: 1.02, 0.85 m/s)
- Power needed to break 1.5 m thick ice in 2 knots: Astern 8.5 MW, Ahead 11.5 M
- Speed in frozen Yenisey channel with 13 MW: Ahead 3.75 m/s (7.5 knots)
- Speed in unfrozen Yenisey channel with 13 MW: 4.5 m/s (9 knots)
- Speed in own 1.5 m thick unfrozen channel with 5 MW: Ahead 4.5 m/s (8.9kn), Astern 4.25m/s (8.5 kn)
- Speed in own 1.5 m thick unfrozen channel with 12 MW: Ahead 7 m/s (14.3kn)
- Average speed in frozen rubble field running astern for 5 miles was 1 knot (no chance to run ahead)

Aker Arctic DAS™

Aker Arctic

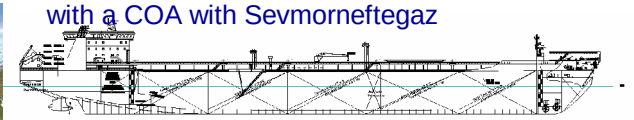
Aker Arctic transport solution already selected for two major Arctic oil projects - Prirazlomnoye

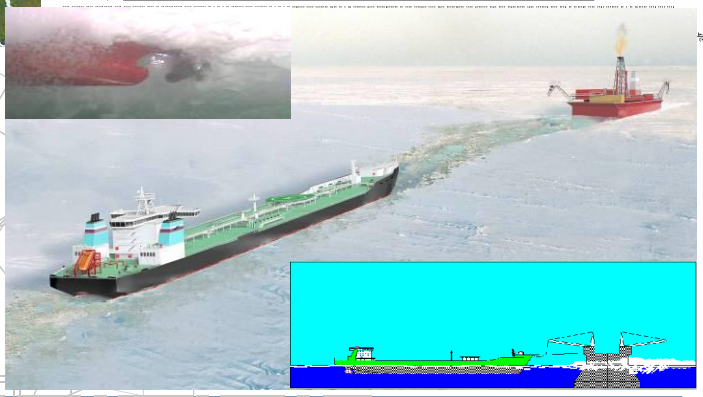
- **Width** 126 m
- **Length** 126 m
- **Height from the sea level** 120 m
- **Weight**(without hard ballast) 110 000 t
  (with hard ballast) 506 000 t
- **Well slots** 40
- **Total caisson capacity** 159 890 m3
- **Oil Tank Capacity** 108 814 m3
- **Maximum daily production** 20 748 m3
- **Staff** 200 people
- **Stock replenishment period** 60 days
- **Life time** 25 years

Aker Arctic 70.000 tdw shuttle tankers for Pechora Sea

Aker Arctic

Prirazlomnoye; Admiralty yard, Owner Sovkomflot with a COA with Sevmorneftegaz

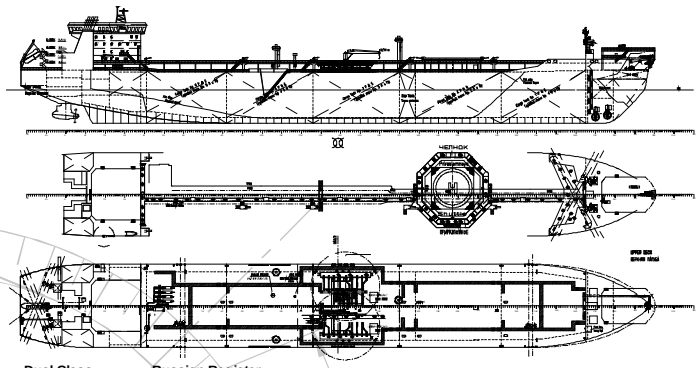




Aker Arctic contract for the Basic Design with Admiralty yard. Two ships to enter serviced in 2009

Prirazlomnoye Shuttle tanker

Aker Arctic



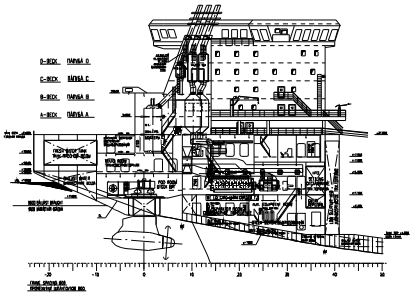
- Dual Class	Russian Register Lloyds Register
- Ice class	LU 6
- Length o.a.	258,75 m
- Beam	34,0 m
- Depth	20,8 m
- Draught	13,6 m
- Deadweight	70 000 t
- Proplusion power	17 MW

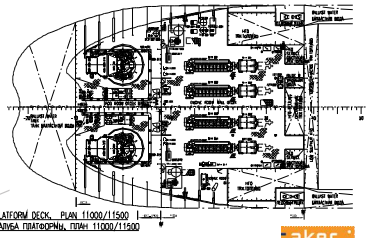
-Basic Design	AARC
- Builder	Admiralty Shipyard
- Owner	SOVCOMFLOT/SMNG
- Keel laying	Summer 2007
- Delivery	End 2009
- Icebreaking capability	1.2 m+0.2m snow, 3 kts

Prirazlomnoye Shuttle tanker, Machinery

Aker Arctic

- **Diesel generator sets:** **4 x 6525 kW**
- **Propulsion Azipods:** **2 x 8,5 MW**





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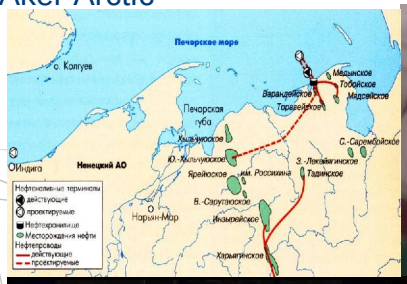
New solutions in Arctic oil exports systems: LUKOil/ConocoPhillips in Varandei, developed by Aker Arctic

Aker Arctic



Sovcomflot contract for three 70.000 tdw vessels with Samsung, deliveries 2007-2009

Aker Arctic

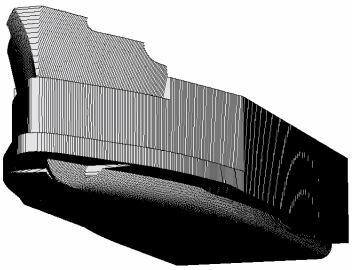
- Another Aker Arctic DAS™ design concept
- World´s first marine Arctic Oil Export system
- In service December 2007
- Final design with twin 2 x 10 MW pod drives, ice class LU6
- Vessel unit price 138 M USD

Drilling ship leads the way to icy operations in Alaska

Aker Arctic

Shell has inititiated a drilling campaign in Alaska for 2007-2009 – the first since mid 1980´s. All the solutions developed and used for this Beaufort Sea operation are based on Aker Arctic´s engagement and solutions. Drillship " Frontier Discoverer" of Frontier Drilling USA Inc, Houston, is the first drilling vessel created for Arctic conditions.

Three of the icebreakers used for ice management in this drilling campaign are built by Aker Yards.



Multipurpose Icebreakers ”Fennica”and ”Nordica” will provide ice management for the Shell drilling campaign

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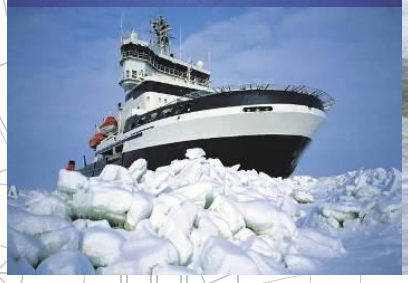

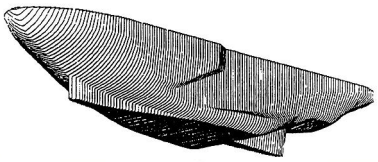

LNG transports from Yamal are possible

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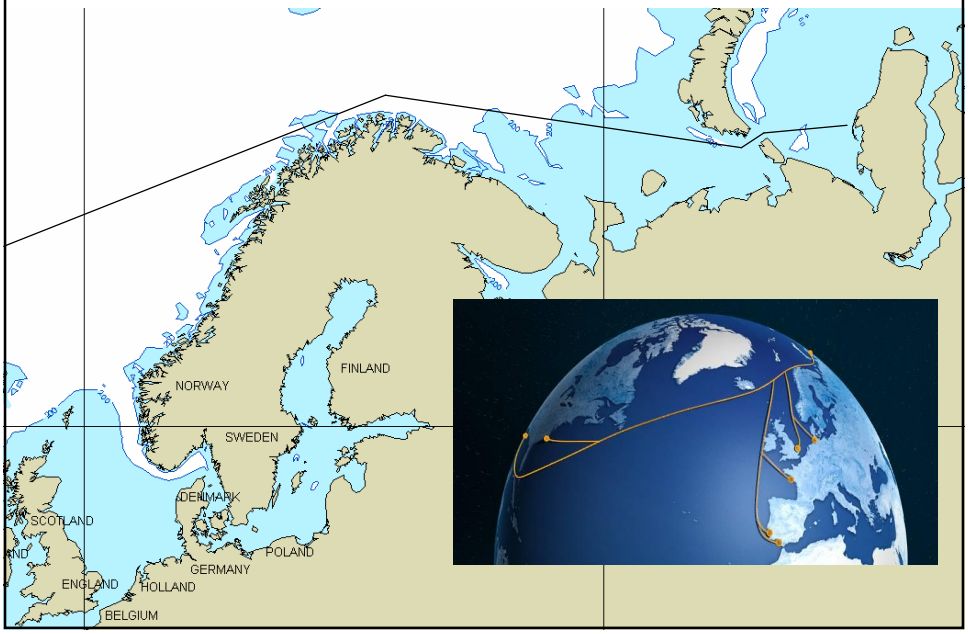

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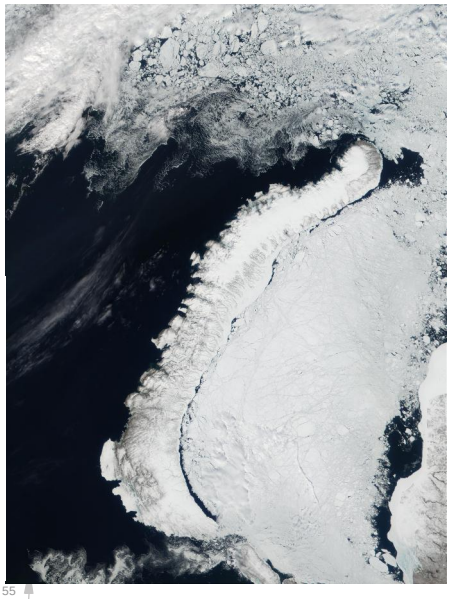
Kara Sea ice massif



Ice thickness at Kharasevey

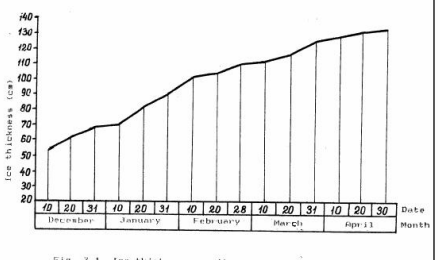


Fig. 3.1. Ice thickness growth near the polar station Kharasavey in 1976 – 1977

Aker Arctic

Aker Arctic LNG

Open water Mode:

The vessel will operate in the open water conditions as the normal tankers.

Podded propulsion provides good open water efficiency and easy arranagement of general spaces.

Ice operating Mode:

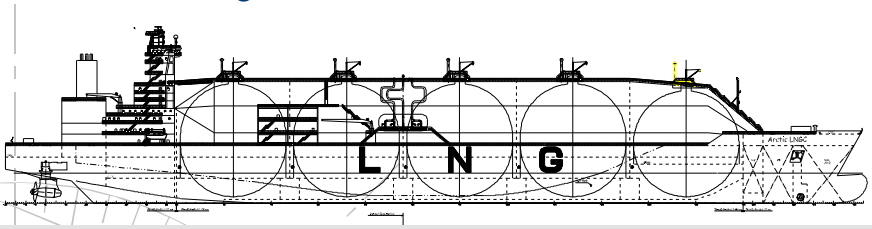
The vessel will operate stern ahead with pulling propellers.

Very good ice breaking capability can be achieved with normal open water propulsion power.

Preferred for Innovation

Aker Arctic

Double Acting Arctic LNG



Main Dimensions		Class	Machinery
Loa	340 m	LR+100A1, Liquefied Gas Carrier,	diesel electric propulsion,
Lpp	324.90 m	Ship Type 2G (Methane in	2 x Azipod: Output 2 x 18,000 kW
Breadth, moulded	50.00 m	independent tanks, Type B, Max.	
Depth	22.90 m	pressure 0.25 kg/cm2, Min.	Diesel generator aggregates
Design draught	12.00 m	temperature -163°C) *IWS, +LMC,	dual fuel total abt. 46,000 kW
Deadweight design	abt. 92,650 t	UMS, NAV1, IBS, SCM, LI, Ship	Fuel consuption 7.3t/h
Scantling draught	12.7 m	Right (SDA, FDA, CM), ICC, TCM	Integrated automation system
Deadweight scantling	abt. 95,800 t		Voltages for main consumers
Gross tonnage	abt. 133,000	Deep well pumps tanks	11kV/6.6kV, 450/230V, 60Hz
Cargo capacity	206,000 m3	155 m.l.c 10 x 1,600 m3/h	Water/CO2/powder fire fighting
Speed design draught	19.5 kn	Boil off rate 0.15%	system
Ice breaking performance @ 5 knots		Combined cargo heater/ vaporizer	Accommodation
astern:1.5m / ahead:70cm		Inert gas/venting plant	Crew cabins incl. Pilot 49 pers.
Radius of action	abt.13,000 nm	Bow thruster abt. 2,000 kW	

Verified performance for Kara Sea

Aker Arctic

Level ice test results astern

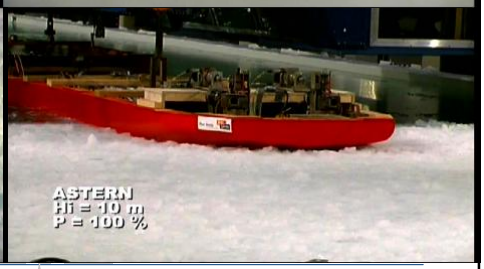
170cm 4.9 knots

150cm 5.4 knot

Ridged ice astern

11-14m 0.8 knots

Heavy ice conditions can be penetrated with the same power level in the engines as are needed for the open water trade!



The real potential is in LNG trades with Arctic DAS carriers

Aker Arctic

Yamal – Europe/U.S. Gulf of Mexico

We have three major ongoing R & D projects:
-for developing large size Arctic pod drives, with CNIIMF, KSRI and RMRS
- for measuring thruster loads in order to find right dimesnioning basis in the future
- for developing contra rotating propeller solutions
-We are working also in projects related to LNG fuel and fuel cells in Arctic, and on ice induced vibrations and impacts to the gas containment system

Ice Coverage Predictions 2000-2100

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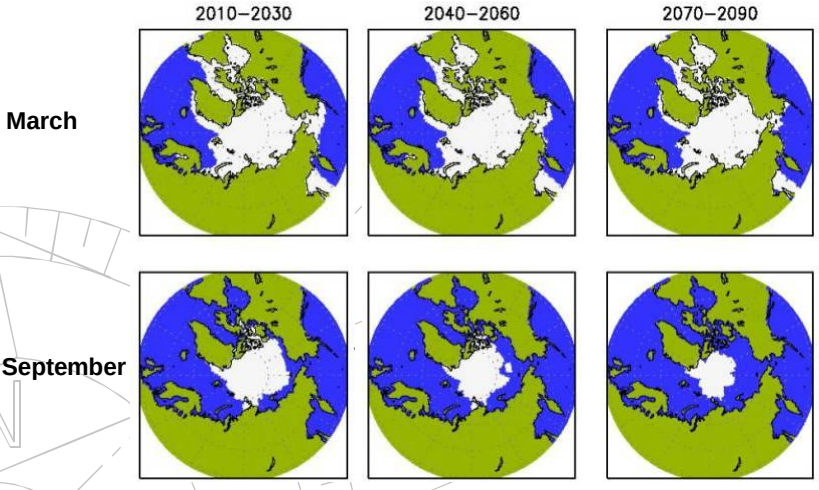

Preferred for Innovation

The Northern Sea Route (NSR) versus Suez Canal Route (SCR)

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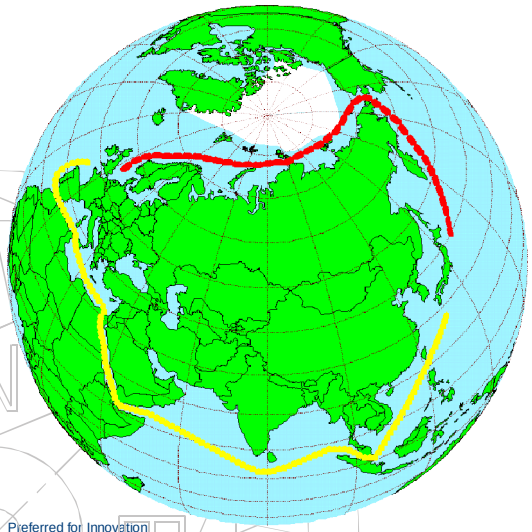

Hamburg - Yokohama

NSR = 6,920 sm

SCR = 11,430 sm

Study for the Instiutute of the North: Trans-polar Containership

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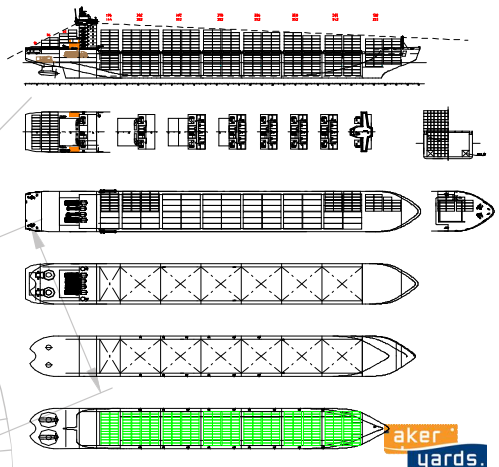
LENGTH OA	281.3 M
LENGTH DWL	269.3 M
BEAM	34.6 M
DEPTH	21.3 M
DRAUGHT DWL	13.5 M
CAPACITY	5000 TEU

The "Norilskiy Nickel" experience has led one step closer to efficient trans-polar cargo liners in "economy-of-scale" sizes.

A feasibility study was conducted for US Government

2 x 17 MW pod drives,

Transit time Alaska-Europe 11 days (summer), 20 days (winter)



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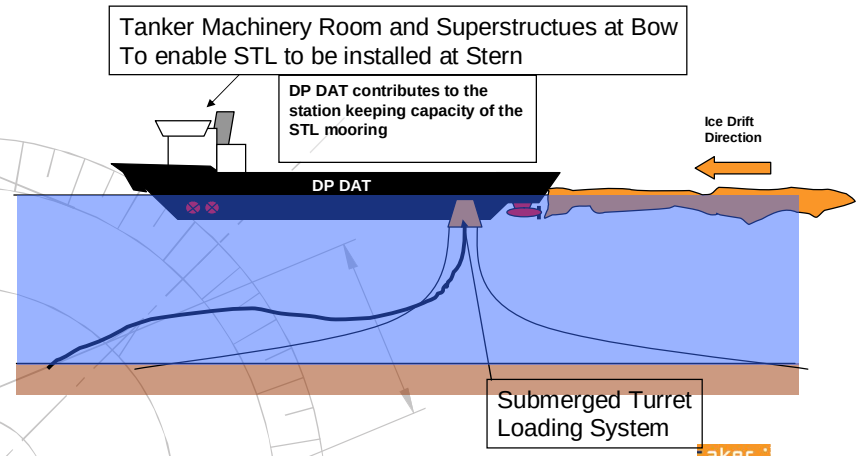
Arctic Tanker Loading – one alterantive solution



Preferred for Innovation

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The next need: Ice-going research vessel, capable of working in ice-covered waters

- **bow thrusters secure the efficient and stable speed in ice conditions**
- **model test results confirm good propulsion efficiency for bow propellers**
- **no disturbing propulsion noises into the scientific system**

- **wide stern secures efficient seismic work**
- **hull form developed to leave a wide open channel behind the vessel**
- **no propellers to disturb the seismic work**

Air bubbling used as noise barrier to isolate from propeller and ice breaking noise

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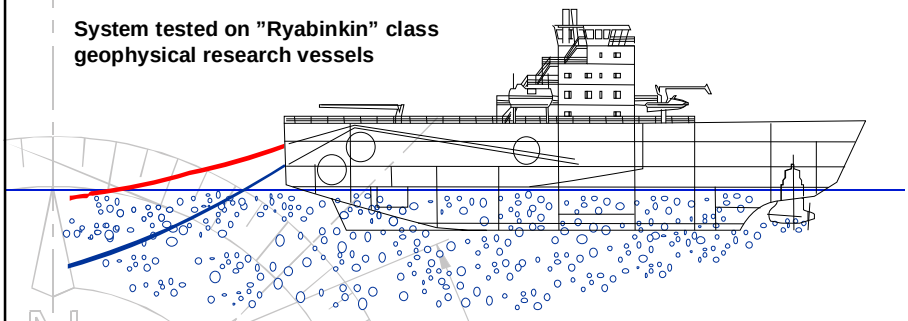
System tested on ”Ryabinkin” class geophysical research vessels



The Aker Arctic wide-stern seismic icebreaker with bow propulsion and an air bubbling noise barrier for work in Arctic environment. Aker Arctic has unique measurement data on underwater noise caused by e.g. the icebreaking itself. A related important study was conducted recently to an Owner wanting so far to be anonymeous.

Winter is our challenge in oil spill risks

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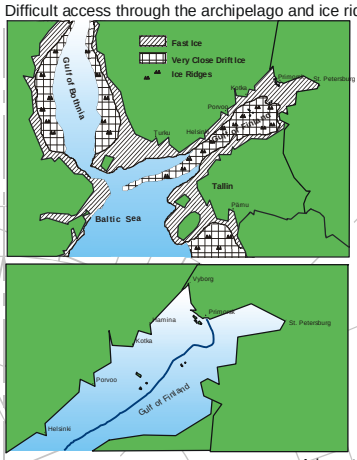
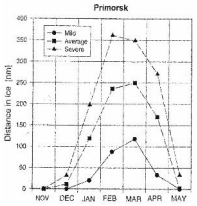
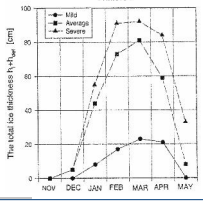
Difficult access through the archipelago and ice ridges



Gulf of Finland with the location of the Primorsk terminal and prevailing winter ice conditions.

	Average ice coverage (days)	Average (maximum) ice thickness
Primorsk	140	50 (90)cm
St. Petersburg	145	55 (90)cm
Porvoo	110	40 (89)cm
Tallin	90	35 (85)cm





A long-term statistical analysis of the

ice conditions for the Primorsk terminal.

K.Riska

Port of Primorsk, 160 Mill tons/year

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IMO notified practice: Two icebreakers escorting minimum an IA ice class tanker

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Safe and reliable

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But sometimes only one is available

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.. or not any available, the whole convoy drifting on terms of the weakest

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Larger vessels are introduced, B-Maxes exceeding 200 000 tdw

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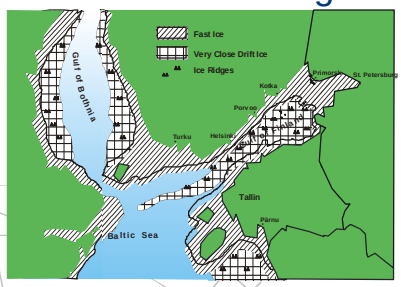

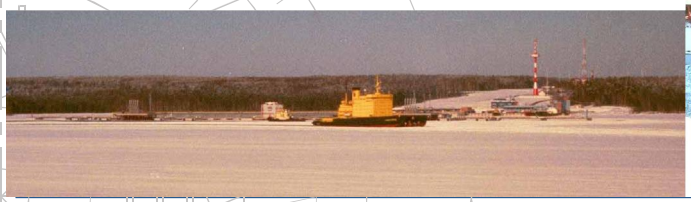

Total ship calls in Russian ports in the Gulf of Finland during winter navigations of 2002-2006

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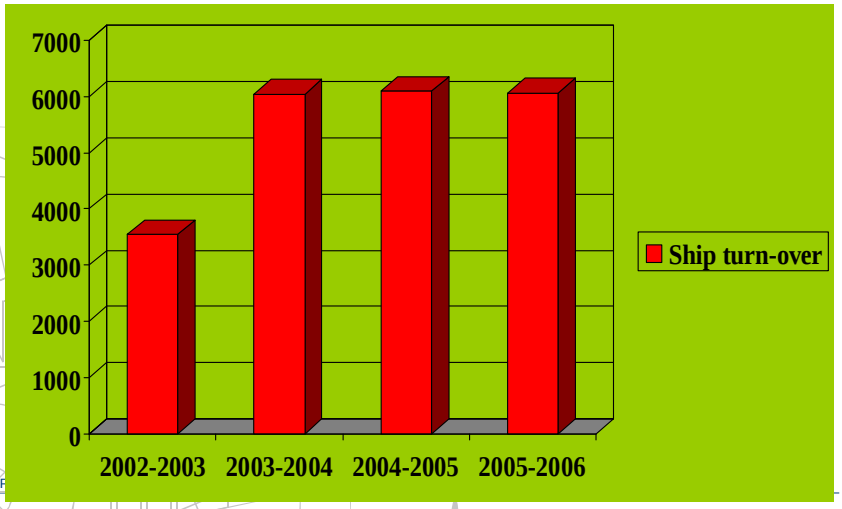

Number of port calls in Russian ports of Primorsk, Vyborg, Vysotsk and Ust – Luga during winter navigations of 2002 – 2006

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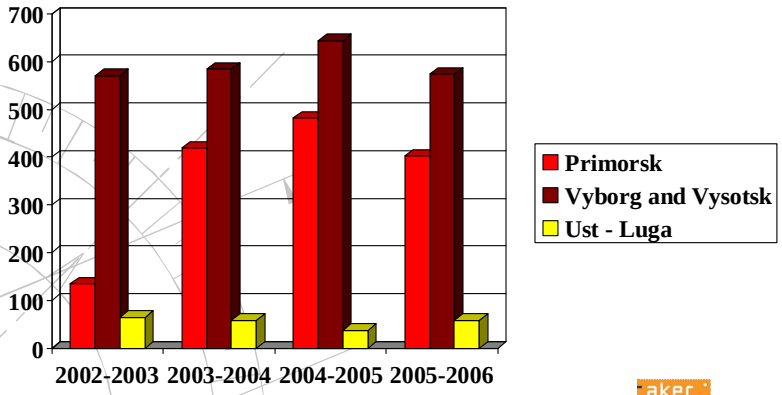

Preferred for Innovation

Total cargo turn-over of all Russian ports in the Gulf of Finland during winter navigations from 2002 to 2006

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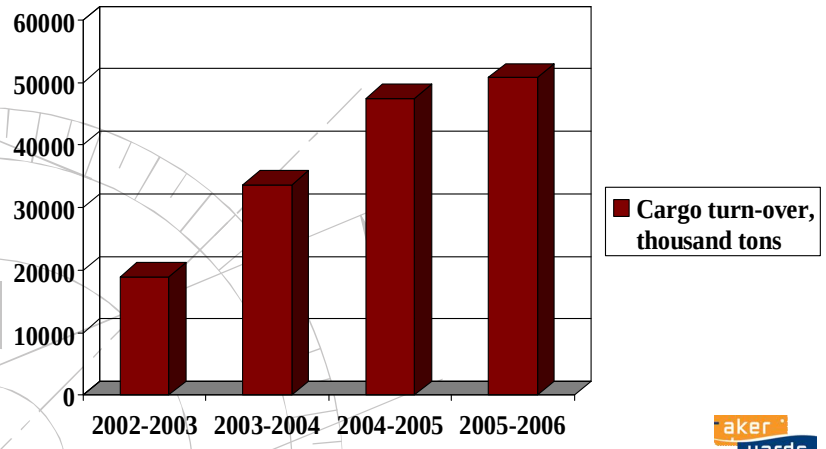

Gulf of Finland examples, February 2003

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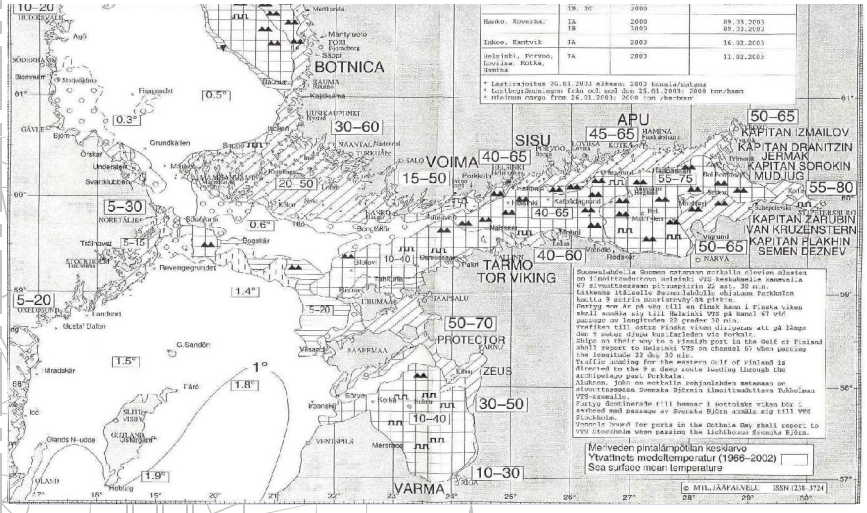

Shallow waters, many turns

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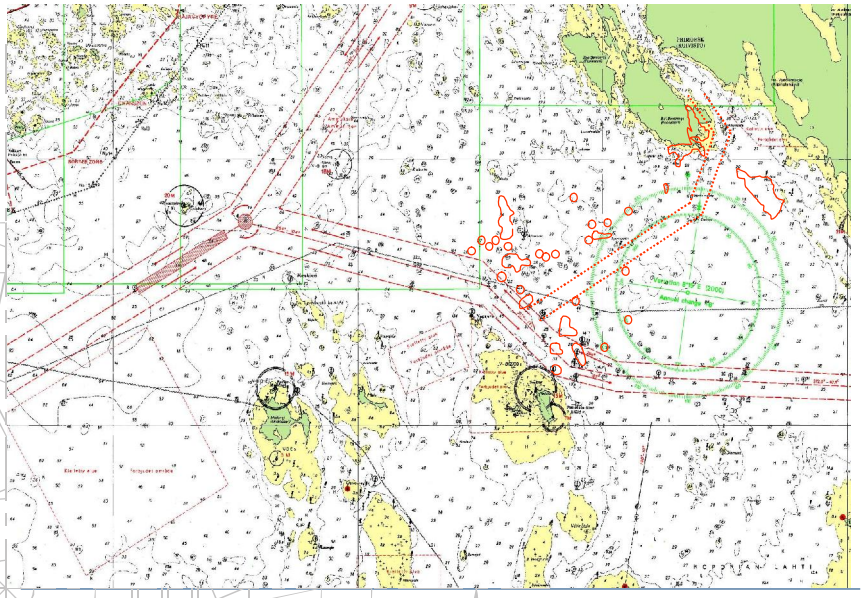

Oil spills, not if but when?

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Case ”Runner”, just fuel not cargo oil

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Typical platform, ORLAN in Sakhalin

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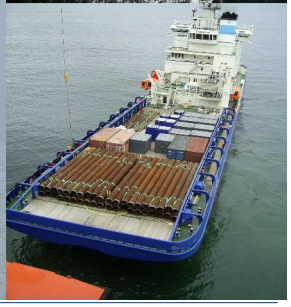
”FESCO SAKHALIN” for Sakhalin 1 (Exxon)



Efficient dispersant management with azimuthing propulsion

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Oil combating icebreaker

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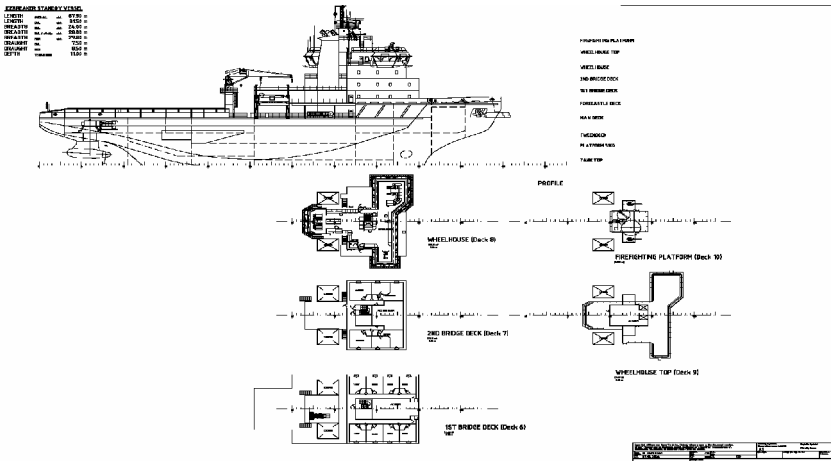

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Another innovation – the oblique oil combating icebreaker for wide tankers

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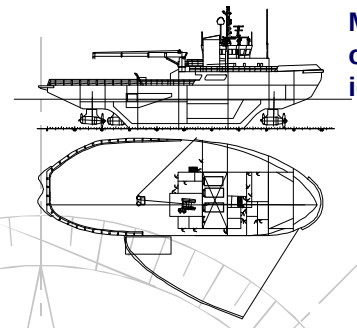
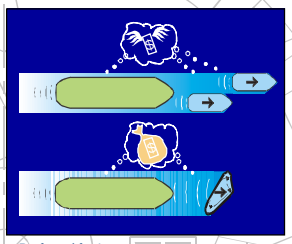


Multipurpose oil combating icebreakers (oblique)

- three functions in one small size hull
- icebreaking by the side
- one 40m wide channel, replaces two traditional icebreakers
- oil combating in heavy ice conditions (ice cleaning vibrator)
- excellent for escort towing



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Excellent added performance values

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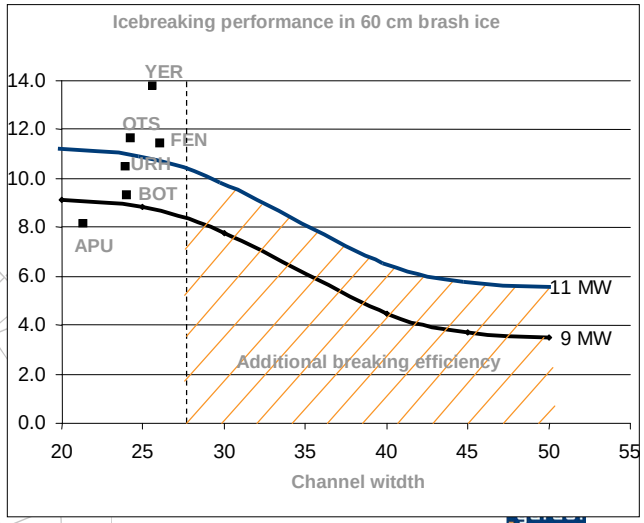

Why should a ship be symmetric?

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4-Nov-07

New ice operation tools

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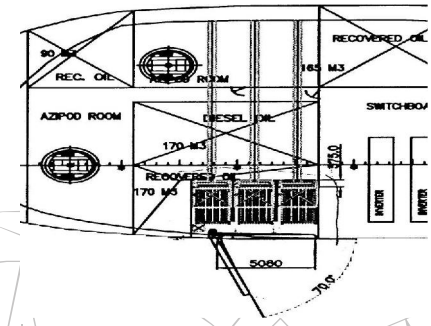

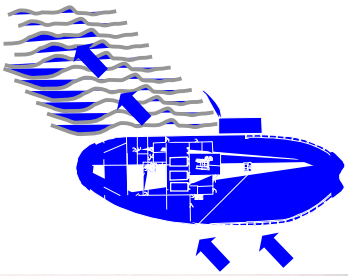

4-Nov-07

Icebreaking trimaran development for icebreaking and oil spill combat

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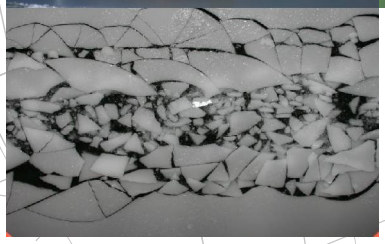

A new innovative, patented solution for icebreaking will give an excellent basis for developing oil spill combat capabilities.

Looking for interested partners for a JIP for the practical concept development studies

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Thank you!

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